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A Class Library for Heuristic Search Optimization

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Class libraries are like poems in that there seem to be more people writing them than reading them. There are good reasons for this in both domains. I don't read very many poems, but I do listen to the descriptions of poetry when they appear on the radio program All Things Considered so my hope is that you will be interested in a brief discussion of a class library even if you don't intend to use it.

Combinatorial optimization problems surface in a wide variety of settings such production planning, robust statistical analysis and engineering design. In this paper, we describe a class library that can be used to attack an extremely broad range of such problems. Heuristic search (HS) methods such as genetic algorithms (GA), simulated annealing (SA), and tabu search (TS) have been applied to such problems. Readers who are not familiar with genetic algorithms may wish to consult the tutorial contained in books on the subject such as those by Davis (1991) or Goldberg (1989) or the proceedings of the latest conference (Back 1997). Simulated annealing is described in many places; we prefer the description by Johnson et al. (1989). A good, general description of tabu search can be found in the new book by Glover and Laguna (1997).

A number of researchers have explored combinations of these and related strategies. For example, Mülenbein (e.g., 1993) has examined combinations of GA and local search. Matsuo et al. (1989) describe a combination of SA and local search. Faigle and Kern (1992) examine a combination of TS and SA. Glover, Kelly and Laguna (1992) look at a variety of ways to combine concepts from GA and TS. New proposals are cropping up all the time.

In this paper we describe a C++ (see Ellis and Stroustrup 1994; the best reference is still Stroustrup 1992; see also Coplien 1994) class library for both pure and hybrid strategies.

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A guiding principle in object oriented programming (OOP) is the creation of classes that define the objects that encapsulate the essential components of the program. These objects contain both data and procedures. So for heuristic search optimization, we must create object classes to represent problems, solutions and the components of HS methodologies.

From a research perspective this library can be thought of as providing a concrete taxonomy for heuristic search. So concrete, in fact, that it can be compiled into machine code. This taxonomy sheds some light on the relationships between heuristic search methods for optimization and on ways in which they can be combined.

From a practical and empirical perspective, the library provides a vehicle for using and testing heuristic search optimization. A user of the library need only provide a problem definition and a neighborhood structure in order to have available a number of techniques. The classes in the library can be extended and/or combined to produce new search strategies. To create this library we encapsulated the characteristics of a number of optimization techniques. The abstractions are independent of problem details.

One of the benefits of discussing class libraries is to consider alternative means of representing the concepts. An alternative approach is given by Gallo and Scutella (1993). In that paper, they describe abstractions of techniques for the maximum flow problem. By focusing on a particular problem, they are able to produce powerful objects for problem solving. Furthermore, their abstractions shed light on the nature of the problem and the methods for solving it. Celso Ribeiro and his group at the Catholic University of Rio de Janeiro are working on a library based on design patterns with a client/server orientation. Andreas Fink and Stefan Voß at Technische Universität Braunschweig have a library that relies on templates and frames, while mine uses more layers of inheritance. Templates make it easier to produce more efficient code and offer some other advantages, but I prefer the "old-fashioned" hierarchical structure because it corresponds to the way I prefer to view the concepts. We will debate the relative merits in a session of the INFORMS meeting in Montreal.

The poetry metaphor breaks down when applied to major commercial class libraries such as the ILOG Solver. They may not quite be comparable in breadth of distribution to romance novels, but their impact is large and growing. The ILOG library for constrained logic programming is moving in the direction of some elements of heuristic search under the rubrics "iterative improvement techniques" and/or "repair heuristics."

LIBRARY STRUCTURE

As we introduce the library, we also introduce a view of the concepts central to C++ libraries in general. The accompanying figure illustrates the relationships between some of the classes provided in the library. If object B is connected to object A by a line with an open triangle pointing toward A, then B is *derived from* A. We say that B *is a* A. We might also say that B is a *child* of A. Children inherit the interface and properties of their base classes.

If an object A has a thin line with a filled arrow pointing to object B, then an instance of object A contains a pointer to an instance of B and object A does not "own" the memory used by object B. We say that A *has a reference to* B. If the line is thick and originates inside the rectangle for A, then A contains an instance of B or points to a B object in memory "owned" by A. We say that A *has a* B.

Classes such as HS_Base that are shown with horizontal rectangles are referred to as *pure virtual* classes because they cannot be instantiated (i.e., object instances of the class cannot be created). Other classes can be written to use the interface of the pure virtual base classes, but when these other classes are instantiated, instantiations of children of the base class are provided. This is the value of inheritance, we can write strategy classes in terms of an abstract neighborhood base class without knowing the details of the neighborhood that will later be defined as a child.

Library classes shown in squares can be instantiated. Of course, one may prefer to derive new classes from them (in order to override some or all of their procedures) and then instantiate objects of these new classes. For example, the class Reactive_Tabu is an implementation of Reactive Tabu Search (Battiti and Tecchiolli 1994). We can see from the "refers to" relationships in the Figure that in order to construct a Reactive_Tabu object, we will

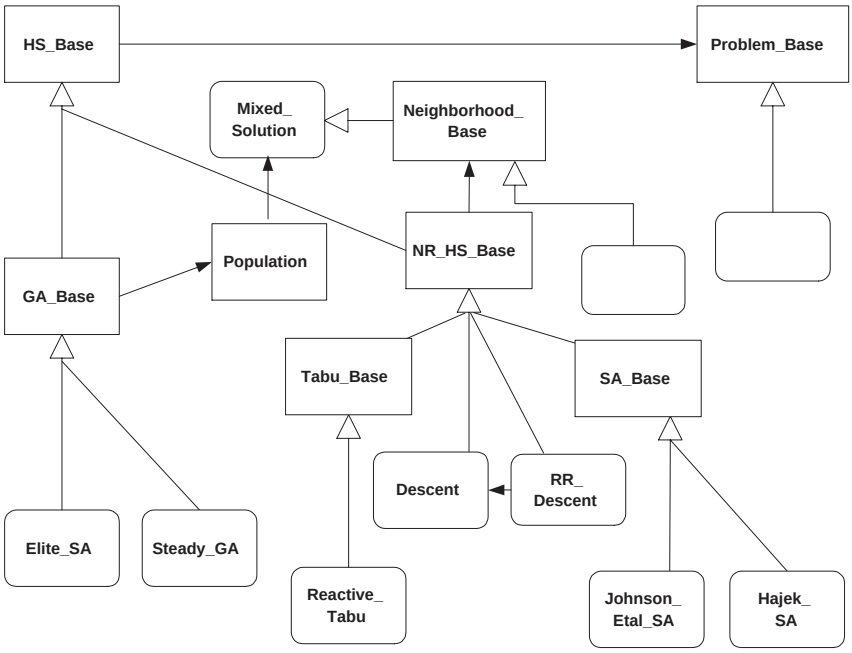

Figure. Class Relationships Diagram

have to provide an object of a class derived from Problem_Base and one from a class derived from Neighborhood_Base. The need for a Problem_Base child comes from the fact that Reactive_Tabu is a Tabu_Base, which is a NR_HS_Base, which is a HS_Base, which refers to a Problem_Base. The need for a Neighborhood_Base child comes more immediately from the fact that NR_HS_Base refers to a Neighborhood_Base.

These chains of inheritance and reference may seem slightly long-winded, but there are benefits, particularly from the standpoint of understanding and studying the relationships between algorithms. The Figure constitutes a taxonomy of simple HS algorithms. It is easily extended to include some hybrid algorithms. Rather than viewing a proposed algorithm as an entire entity, we can break it into its components. Does the algorithm work well because of its neighborhood structure, problem representation or because of the strategy employed? The library lets us quickly mix and match components.

The taxonomy developed to this point also provides an interesting way to reflect on a claim that was made by the late Gunar Liepens. He was fond of saying that GA's required less "hand-crafting"' than tabu search or simulated annealing. This statement can be rendered correct or incorrect depending on the interpretation of "hand-crafting." Our taxonomy shows one interpretation that supports Liepens statement. In order to instantiate a GA, one need only specify a problem object. Of course, the avoidance of "hand-crafting" is not necessarily the most important objective one has when constructing a computer program for heuristic search optimization, which is why we have devoted most of our attention to design issues associated with tabu search.

A gap in the center of the figure could be used to show the relationships between hybrid search strategies and the base strategies in the library. An important contribution of the library is to provide abstract hybrid strategy definitions. That is, concrete specification of the relationship with base strategies (or their children) but descriptions that are independent of a problem or a neighborhood structure.

A number of classes are not shown in the figure because they involve more detail than is appropriate for this overview. However, some of these details also present interesting issues in the representation of the concepts associated with heuristic search. For example, decisions must be made about how to represent the concept of a mixed solution. Other classes are omitted because they are somewhat specialized. For example, there is a class that provides an interface to the XOSL solver provided by Dash and Associates.

USING THE LIBRARY CLASSES

In order to use the library to solve a problem, a problem class must be defined. It must have Problem_Base as a public base class. For most strategies, a neighborhood class must also be defined with Neighborhood_Base as a public base class. This is shown in the figure using empty classes. Objects of the new class types must be instantiated and then passed to the constructor(s) for the desired search objects. All search classes are children of

HS_Base and therefore have the method Go(Iters), which starts the search with an iteration limit given by Iters.

This class library may not remind you very much of poetry, but there are more similarities than you might think. Many of the issues are matters of personal taste and excellent starting points for intellectual discussions. I have a vague recollection from Freshman English of some pointed comments that Ezra Pound made to T.S. Elliot concerning the "The Wasteland." Please flatter me and yourself with the comparison to the great poets and send your criticisms of the library architecture to the author at *dlwoodruff@ucdavis.edu*.

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1998 INFORMS/CSTS Prize: Call for Nominations

Nominations are invited for the INFORMS Computer Science Technical Section (INFORMS/CSTS) Prize. The prize will be awarded at the Spring 1998 INFORMS Meeting in Montreal, Canada. The prize committee consists of Anna Nagurney (Chair, UMass Amherst), Panos Pardalos (U of Florida), John Tsitsiklis (MIT), and Hanif Sherali (VPI &SU).

The objectives of the prize are

- to promote the development of high-quality work advancing the state of the art in the operations research/computer science interface;
- to publicize and reward the contributions of those authors/researchers who have advanced the state of the art; and
- to increase the visibility of excellent work in the field.

To be eligible for the prize, a nomination must be

- published in the open literature;
- pertinent to the operations research/computer science interface; and
- written in English.

Nominations must include the title, author's name, place and date of publication(s), and a copy of each nominated work (in quadruplicate, please, if the work is not both easy and legal to photocopy; please say whether you would like the nomination material returned to you after the committee has considered it). Nominations must be received by February 15, 1998, and should be sent to the following address, with a cover letter justifying the nomination.

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CSTS'98: *6th* INFORMS CSTS Conference on Computer Science and Operations Research: Recent Advances in the Interface

January 7-9, 1998, Monterey, California, USA

You are invited to attend the Section's sixth conference on recent advances in the CS-OR interface to be held in beautiful Monterey, California, on the Pacific coast. Program highlights include a plenary address by Claude Le Pape, a series of surveys and tutorials, presentations on state-of-the-art research and practice, and commercial software demonstrations. This meeting will be smaller and more focused than the national INFORMS conferences, and in the tradition of its stimulating and enjoyable predecessors.

PROGRAM HIGHLIGHTS

Plenary Address

The plenary address will be given by Claude Le Pape, who is well known for his seminal work in Constrained Logic Programming. Title: *From Constraint Programming to Hybrid Problem-Solving Algorithms: Applications, Tools, and Methodology*

Surveys and Tutorials

Leading researchers and practitioners present in-depth summaries of the state of the art in:

- Computational Aspects of Large Scale Stochastic Programming *Suvrajeet Sen and Julia L. Higle, University of Arizona*
- Implications of Constraint Logic Programming for the Design of Mathematical Programming Systems *Robert Fourer, Northwestern University*
- Interior Point Methods for Nonconvex Nonlinear Programming *David Shanno, Rutgers University*
- Local Computation of Gaussian Belief Functions *Liping Liu, Susquehanna University*
- Neural Networks and Linear Programming *Asim Roy, Arizona State University*
- Optimization and Constraint Satisfaction *John Hooker, Carnegie Mellon University*
- Post-Solution Analysis in LP From an Interior Solution *H.J. Greenberg, University of Colorado at Denver*
- Visualizing Multidimensional Geometry with Applications to Multivariate Problems *Alfred Inselberg, San Diego SuperComputing Center*

Current Research and Practice

Individual clusters of presentations will be given on:

- Combinatorial Optimization *Bertrand M.T. Lin, Ming-Chuan University*
- Cooperating Solvers *Carol Tretkoff, CUNY*
- Decision Support Modeling *Dan Zhu, University of Iowa*
- Distributed Systems *Suresh Sridhar, Naval Postgraduate School*
- Healthcare Applications *Rema Padman, Carnegie Mellon University*

- Heuristic Algorithms for Combinatorial Optimization *Mauricio G.C. Resende, AT&T Labs Research*
- Heuristic Methods for Vehicle Routing Problems *Sam R. Thangiah, Slippery Rock University*
- Hybrid Methods *Stephan Voss, Technische Universitaet Braunschweig, Germany*
- Intelligent Systems for Spacecraft Operations *Ben Smith, Jet Propulsion Laboratory, and Barin Nag, Towson University*
- Java - Introduction and OR Applications *Gordon Bradley, Naval Postgraduate School*
- Memetic Algorithms *Pablo Moscato, Universidade Estadual de Campinas*
- Modeling Interfaces *Robert Entriken, Stanford University*
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- New Advances in Memory-Based Search *Erik Rolland, Ohio State University*
- New Computational Methods for Markov Decision Processes (MDPs) *William T. Scherer, University of Virginia*
- Optimization and Decision Support Systems *Gautam Mitra, Brunel University*
- Parallel Branching Methods *Jonathan Eckstein, Rutgers University*
- Post-Solution Analysis in Mathematical Programming *H.J. Greenberg, University of Colorado at Denver*
- Recent Advances in Artificial Intelligence for Human-Computer Interaction *Laura C. Davis, Naval Research Laboratory*
- Scheduling *Edward Wasil, American University*
- Sensitivity Analysis and Optimization in Simulation *Michael Fu, University of Maryland*
- Solving Multicommodity Flow Problems *Richard McBride, USC*
- Statistics and Data Mining *Matthew J. Saltzman, Clemson University*
- Stochastic Optimization *Kevin Wood, Naval Postgraduate School*
- Visualization *Richard Brooks, CSU Monterey*

Professional Development

Rick Rosenthal's popular GAMS Short Course: Optimization Modeling and Problem-Solving Using the General Algebraic Modeling System will be held at the same hotel January 12-15, 1998. For more information and to register for this course see http://www.gams.com/courses/rrcourse/index.htm.

CONFERENCE VOLUME

An edited and refereed volume based on papers submitted by conference participants will be provided to each conference registrant.

Conference Hotel:

The conference hotel is the Carmel Mission Inn 1-800-348-9090 (FAX 1-408-624-8684). The name reflects the hotel's location near the historic Spanish mission in Carmel, California. The special conference rate is $69 per night plus taxes.

The hotel is south of Monterey and on the south side of Carmel on Highway 1. Cab fare from the Monterey airport is about $15. Driving time from the San Francisco International airport is about two hours or more (depending on the time of day).

On Wednesday and Thursday nights, there will be a special shuttle bus to take conference participants between the hotel, the wharf area and the Cannery Row shopping area.

Conference Home Page

For registration and detailed meeting information, see the Conference Home page at: *http://www.gsm.ucdavis.edu/~woodruff/csts.html*

General Chair:

Address questions to the general chair by email (*dlwoodruff@ucdavis.edu*), FAX (1-916-752-2924), or regular mail:

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A Review of a Web-based "Mathematical Programming Glossary" by Harvey Greenberg

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Since 1994, the Web has captured the imagination of the World. Its support for multimedia, its ease of use—by information consumers and providers alike—has made it a medium for purposes ranging from commerce to education. In OR/MS, several efforts have been made to further OR/MS education via the Web. For example, NEOS (*http://www.mcs.anl.gov/home/otc/*) provides access to computational solvers and sample applications illustrating their use. In this article, we review a glossary of mathematical programming terms, developed and maintained by Professor Harvey Greenberg at the University of Colorado, Denver.

Besides drawing the attention of the CSTS community to this effort, we attempt to articulate issues related to design, creation and maintenance of a web-based resource, using the Glossary as a specific example. We also provide Prof. Greenberg with the opportunity to reflect on, and discuss, issues related to creation of this resource.

REVIEW CRITERIA

In reviewing this application, we had to look from different perspectives. First and foremost, this site provides a glossary: therefore, Content (comprehensiveness, depth, quality) is critical. Second, any glossary must have aids to Navigation; an electronic one raises expectations higher. Of particular importance are tools that help users stay focused and not get lost in hyperspace even while being able to follow a concept in depth. Third and fourth, in the context of a Web-based application, there are issues of Style (use of design features, color, frames) and Accessibility (what users need to access the site).

In reading this review, one should keep in mind that the glossary is available on the Web at *http://www-math.cudenver.edu/~hgreenbe/glossary/glossary.html*. We encourage the reader to visit the Web site and experience it on their own; this will help elaborate our brief comments and clarify issues specific to the design, creation and maintenance of a Web-based OR/MS resource.

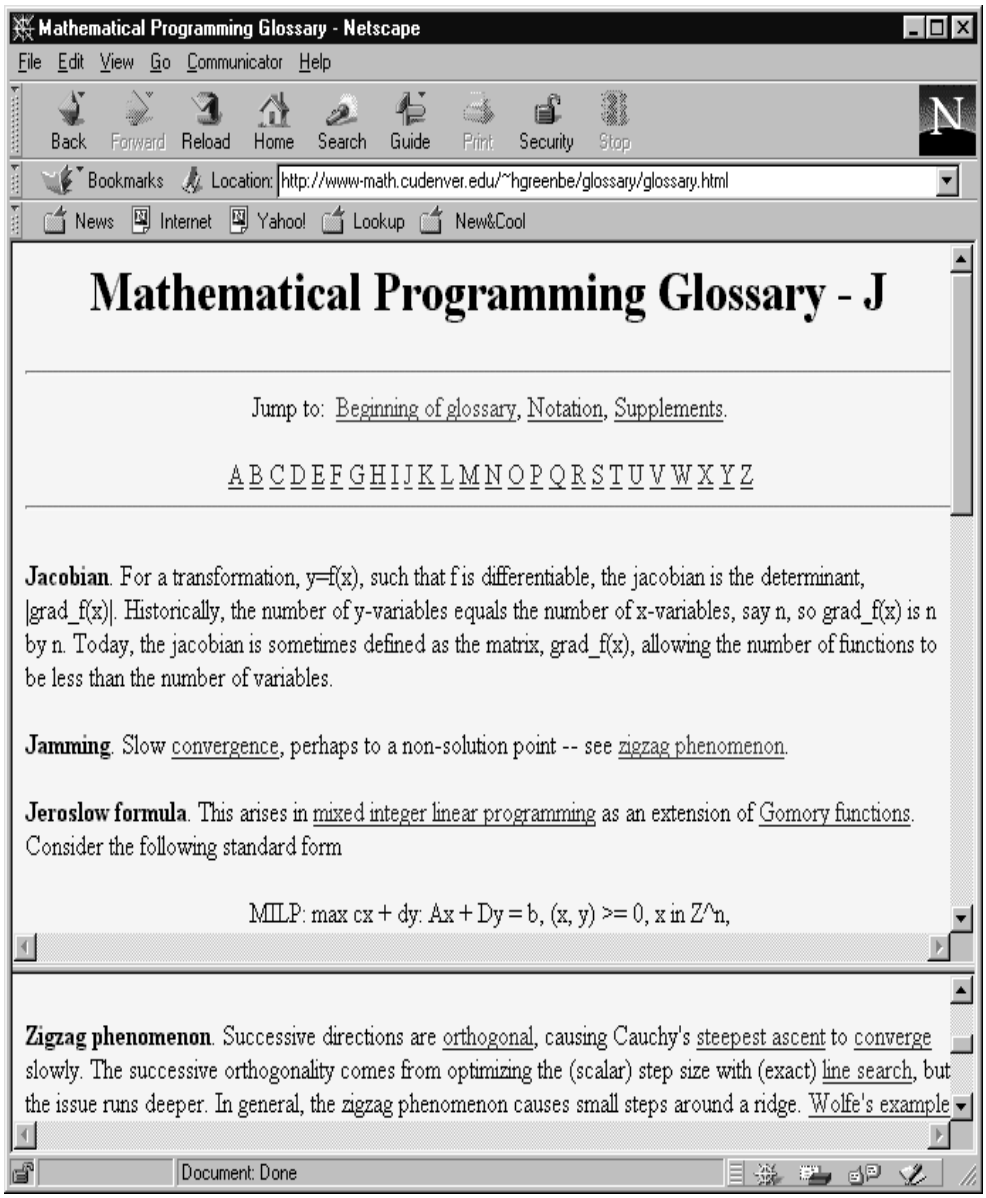
REVIEW

We reviewed the glossary over several days, and refined our findings based on discussions with other colleagues and Harvey (for clarifications). Here is what we have to report.

Content

From initial modest beginnings, the glossary now has about 600 terms covering mathematical programming and related areas. For each term, a definition is presented, along with hyperlinks to related terms mentioned in the definition. Where appropriate, terms are defined mathematically, and all of this is done using a common vocabulary, notation, and style. We found broad coverage of terms in linear, integer, nonlinear, and stochastic programming. Additional terms related to the mathematics of these techniques (e.g., polytopes, NP-completeness) are also defined. We did not conduct any scientific measurement of the glossary's completeness for two reasons. First, we did not know what to use as a benchmark. Second, the very nature of a Web-based resource permits evolution. Thus, while the glossary has been fairly stable in the last few months, it does undergo minor changes, and provides ways for supplemental growth.

In examining the content in terms of quality, the question that arises is: Who is the audience? Is this glossary site meant for OR/MS experts, newcomers to the field, or outsiders? These questions are not answered explicitly on the home page of the glossary. Since the site provides a glossary rather than, say, an encyclopædia or a textbook, it does not (and should not be expected to) provide intensive information on each term. Experts are unlikely to refer to the glossary for definitions in their areas of work; however, it may be a useful starting point for research into related sub-fields. With each term being cross-referenced to related terms, it should help determine a set of terms to explore further. This makes it an excellent resource for students, and more generally for newcomers and outsiders to the field. (Please see the interview below, where Harvey Greenberg addresses the question of who the target user is.)



Example screen, Math Programming Glossary, *http://www-math.cudenver.edu/~hgreenbe/glossary/glossary.html*

While the glossary does well at providing a brief definition for a term, we felt it would be useful to have pointers to online resources that contain additional information, or to executable animations or implementations of a described technique. While this would expand the scope of the effort and take it beyond the typical glossary that one sees in print, it would be just the sort of evolution that leverages the nature of the Web.

Navigation

The glossary appears, to the user, as a collection of terms that are organized alphabetically. Users can access terms in the glossary by clicking on a letter in the alphabet-navigation bar provided both at the top and bottom of each page. Within each file (an alphabetized list of terms), clicking on a hyperlinked term leads to the file containing the term and its definition or explanation. This basic design is enhanced using a two-part frame design; this is available to users with frame-capable browsers. For these users, each page is divided vertically into a top and a bottom frame. While browsing a list of terms (say, those starting with the letter A) in the top frame, a click on a hyperlinked term displays the relevant part of the alphabet file in the bottom frame.

Overall, the frame-based design seems well thought-out and executed, and allows users to focus on a specific

concept while exploring related ones. However, at times, this design appeared to be somewhat limiting to us. When a term in the bottom frame is clicked, it populates the same frame with the file containing the definition or explanation of the term. Thus, the semantics of browsing are different in the top frame and in the bottom frame. An alternative to explore would be the use of new target browser window or to display in the top frame the result of a click on a term in the bottom frame.

An important navigation issue is support for search and retrieval of terms in the glossary. Currently, an alphabetized listing is the only way to locate a term in the glossary. This requires the user to know the terminology for the concept she wishes to understand. While this is a reasonable expectation that one might have of a student who has the benefit of direction from an instructor, it can be quite an onerous requirement for a newcomer. This aspect could be improved by providing a higher level concept hierarchy that would help the user identify a specific term in the glossary.

While the alphabetical navigation bar does allow one to get down to a specific term—provided you know its name—it does not provide any support for "inverse search." This is the ability to determine all the places a term is used in; it should be useful in giving, say, a researcher an initial set of related terms. This can easily be addressed by placing a full-text search engine on the documents containing the glossary, and is fairly commonplace in Web-based systems. A more sophisticated and complex scenario involves an associative text search, conducted using indexes developed through some recursive algorithms based on word association.

In general, in designing aids to navigation, it is very important to support serendipitous search. So, an interface that provides very precise navigation is actually quite limiting. Serendipity is supported, to some extent, both by including conceptually-associated terms (as in a thesaurus) and by including lexicographically-associated terms (as in a dictionary, and as currently done in the glossary) along with the selected item.

Style

The site is well designed and makes thoughtful use of colors and graphical images to maximize user experience. For instance, color is used to differentiate glossary supplements, counterexamples, and the section on myths. When a user clicks on a term, the background color of the file containing the resulting explanation is used to cue the reader about the file's type. Similar thought has gone into the use of GIF images of mathematical notation. To ensure maximum access, the site allows users equipped only with lightweight browsers (such as Lynx on DOS machines) to see textual abbreviation of mathematical notations, and users equipped with modern GUI browsers (Internet Explorer or Netscape 3.0 and above) to view GIF images of mathematical notation and equations.

Accessibility

The glossary scores highly on this dimension. The site has been designed to be accessible to different user communities—from those equipped only with modest technology such as the Lynx browser to those with the latest version of Internet Explorer or Netscape. Examples are in the multiple options to access the site with or without frames, the use of background color and graphical images.

We examined several other glossaries and this one came out near the top on style and usage of web technologies to deliver ease of use and functionality. However, some limitations remain (see findings and suggestions in the review section above). We would like to conclude this review by commending Prof. Harvey Greenberg on having created an excellent resource for the community. This is a new area, and we are very happy to see that someone is keeping OR/MS in the forefront.

INTERVIEW WITH PROFESSOR HARVEY GREENBERG

This interview is based on written and verbal comments to a series of questions. Both the original questions and the answers have seen minor editing, for reasons of organization, format, and space.

You've obviously spent a lot of time and effort in creating the glossary. Could you describe how this site came about: What did it take to build? When did it start? What resources were required?

It all started in Fall '95, just me. In the end, I spent more than 1,000 hours over a period of about 10-11 months. I used my ps2/dos3.3 at first, with just the Lynx browser at home, plus the department's system under Netscape at school, which supported some graphics. That was it for most of the calendar time. In May 1996, I got a Pentium and my student, Allen Holder, set it up for me with linux. That is very powerful and I could do just about anything.

Who was your target user?

I first intended to have a glossary for students in the Spring '96 semester and thought I'd spend a couple of weeks. By December I already spent more time and the "project" began to grow. I spent most of the semester break on this, but I slowed down February-March due to other priorities. By then I realized I had crossed some line, as my glossary grew and the design became more sophisticated. I then thought it would be done by May and started to elicit comments from a few friends, includ-

ing students. I released the first version sometime in July 1996 and broadcasted an announcement over some newsgroups.

The student was the original target and still is a primary one. I have had some e-mail from others, such as people outside our profession (e.g., in physics) and people in industry who had very little coursework in mathematical programming. While these people will present a growing demand, I think the student will continue to be the primary target.

Did you use any formal hypertext design method in building the Web site? How do you maintain and evolve it, and using what resources (manpower, tools)?

It became formal when I got into the design from a broader perspective. By the spring of 1996 I had read a good deal about Web design, primarily motivated by the glossary. I did not use any special tools though.

At this point, the maintenance is not too much work. I occasionally receive an e-mail that results in adding or revising an entry, but now the glossary is fairly stable.

Manpower is just me. I am the only one who can change the glossary. I use the vim editor (ugh!) for most things. For parts of supplements I use xfig to build a figure, and I use latex for generating postscript. I also use latex2html for one set of supplements (which are clearly marked as such).

Given ease of getting material published on the web, how does one establish credibility? For instance, what are your thoughts about getting certified by a professional society? What about making this a community volunteer effort (as we see in ISWorld) or transitioning it to a society such as INFORMS?

This is a real problem, and I believe it's up to our professional societies to assume the leadership. While we're seeing many private journals emerge, those with some affiliation with a professional society would prevail. In mathematical programming there are several societies that have studied this, such as INFORMS (I applaud Ramesh Sharda's efforts with ITORMS). SIAM is still studying where they might go, and the Mathematical Programming Society has (as far as I know) taken a wait-and-see position.

Certification is tricky, but a society with a reputation earned over decades of publications can do a lot more to separate the quality from the trash. Marketplace determination can also be tricky, if taken out of context. Just because a lot of people visit a site to get information doesn't guarantee that they are getting good information. Search engines don't really filter the matches for the browser. If we left research publication to the marketplace alone, many good papers would not appear and many shallow ones would.

Volunteer efforts can be good if the volunteer is not only capable, but also committed. The glossary became a driving force in my life for several months and remains an important part of it. We have all run into editors who seem disinterested in doing their job effectively, as some take as much as a year just to find the referees. Personally, I find that unacceptable, and those that would contribute on the web less than their full commitment to whatever they do might do a greater service by not doing anything.

Tell us something about your future plans regarding the glossary.

One direction is to build up the supplements. I have invited people to submit one to me, but so far no one has.

Another direction is to use the glossary within courseware. I have put an LP short course on the web, using the glossary extensively. In each of the ten lessons, one starts with selected entries. I then point to other people's web materials and guide the reader through the topics. After five lessons (midterm) and at the end I give a long list of selected glossary entries. This could be a model I hope others would use. The glossary is freely available (see the "Morality Code" I give in the glossary) and I think it would be useful at least to announce its existence to students at the outset of the course. If the Web is used at all, a link to the glossary would be appropriate and students might be encouraged to bookmark it themselves.

I don't expect the content to change any more than mathematical programming itself changes. I do have a lot of mathematical terms, which one could use in its own right, and this might grow as the need demands. The major growth that I would like is with the supplements. Design details could change as the technology changes. I like the fact that anyone can access the main entries and most supplements, but eventually I would expect greater use of video, particularly animation. Such advances might best be done with supplements or options within entries such that it remains possible to understand an entry with nothing more than Lynx.

I put a great deal of thought into things most people would not notice (if they did, I probably should have thought some more). One example is color, another is the use of frames. I struggled over these, experimenting with alternatives and trying them out on friends and students. (Please see my acknowledgments in the glossary.)

In closing, let me add that I have great expectations from the use of the Web for teaching. It already helps a lot, and I feel good about the way the glossary has turned out. I regret that it has no official status in the mathematical programming profession, and I hope it can evolve in a way that goes beyond my lifetime. Perhaps that will happen. Meanwhile, I continue to use it and invite contributions that would make it better. ●

The ILOG/CPLEX Merger: New Opportunities in Optimization

Gwyneth Butera and Carol Tretkoff

The merger of CPLEX and ILOG this past August has created an opportunity for new directions in the solution of problems arising in combinatorial optimization and mathematical programming. The combination of CPLEX's LP, MIP, and QP software and ILOG's object-oriented, constraint satisfaction software [4] means that there will be more "arrows in the quiver" for the operations research professional. In particular, the integration of these tools will facilitate the expression of logic and cardinality constraints on the modeling side as well as the opportunity to use more than one type of solving engine on the solution side. Indeed, while there has been research in the area known as cooperating solvers, combining finite domain constraint propagation and linear-programming-based methods within a single application has heretofore not been an easy process for operation research analysts.

Modeling a problem as a MIP application often involves constraints that have to be "pushed into" linear constraints in an unnatural way. These requirements can often be expressed directly and efficiently with constraint satisfaction software by using generic constraints on an array of variables. So, the integration of ILOG and CPLEX will result in an increase in modeling power for a wide range of problems.

For NP-hard problems, both finite domain and continuous methods must resort to search techniques, working on subproblems in order to prune the search space. For continuous methods, the simplex algorithm is the basic constraint-solving tool, while for finite domain methods, an analogous role is played by arc-consistency algorithms such as AC5 [7]. For example, at each node in an LP-based branch-and-bound tree, a linear relaxation of a subproblem of the original problem is solved, and the information from this solution is used to determine whether or not the subtree of the current node can be ignored. At each node in a discrete constraint-based search tree, constraint propagation algorithms are invoked so that the domains of the variables are reduced as much as possible. These methods include generalized arc consistency algorithms for handling cardinality constraints [5] such as "all different" and edgefinder algorithms [1,2] for handling discrete resource constraints in scheduling problems.

Both continuous methods and finite domain techniques have their individual success stories. For example, LP-based methods are particularly good with set covering problems, while finite domain methods are a better choice for job shop problems. Indeed, sometimes the geometry that can be captured in the linear programming formulation of a problem can be very powerful. On the other hand, if there is no way to formulate an efficient tight LP relaxation, finite domain constraint propagation can prove to be the method of choice.

Cooperating solvers are not completely new to the OR field. For example, MIP preprocessing itself is a linkage of a solver based on discrete constraint propagation with an LP-based MIP solver [6]. Maintaining a dialogue between discrete and continuous engines beyond the initial stage has been shown to have promise by several research teams; for an overview see [3]. In particular, by using cooperating solvers, one can model the logical and non-numeric parts of an application in the appropriate discrete framework while retaining the power of the LP relaxation. This combination of tools opens new opportunities for OR research and practice.

References:

[1] Carlier, J. and Pinson, E., An algorithm for solving the job shop problem, *Annals of Operations Research* **26** (1990) 269-287.

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[3] McAloon, K., Tretkoff, C., and Wetzel, G., Disjunctive programming and cooperating solvers, *Advances in Computational and Stochastic Optimization, Logic Programming and Heuristic Search*, Edited by David Woodruff, Kluwer, 1998, 75-96.

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[5] Regin, J-C., Generalized arc consistency for global cardinality constraints, *AAAI-96, proceedings of the Thirteenth National Conference on Artificial Intelligence*, Portland, Oregon, 1996, 209-215.

[6] Savelsbergh, M., Preprocessing and probing techniques for mixed integer programming problems, *ORSA Journal on Computing* **6**, 445-454.

[7] Van Hentenryck, P., Delville, Y., and Teng, C.-M., A generic arc consistency algorithm and it specializations, *Artificial Intelligence,* 57, **1992**.l

Member Profile: Bjarni Kristjansson

Mr. Kristjansson, born in Iceland, is the President and founder of Maximal Software, Inc. He attended the University of Iceland where he obtained a BS degree in Computer Science. In 1987, he formed Maximal Software, which specializes in making software for optimization modeling, and is the developer of the MPL Modeling System.

Mr. Kristjansson's current research and development projects concentrate on recent advances in computer science and how they apply to optimization modeling in real-world applications. These include: Graphical User Interfaces; Relational Databases; Client-Server Technologies; and Optimization Modeling on the Internet.

Mr. Kristjansson's career in Operations Research began during his studies at the University of Iceland here he became interested in the field due to a class project. One of his class assignments was to solve a 4x5 linear programming problem by hand and instead of doing the assignment, Mr. Kristjansson spent an entire weekend writing a Simplex code on his personal computer. This original code then developed into his first commercial product, Turbo-Simplex, for his new company, Maximal Software.

In 1987, Mr. Kristjansson started Maximal Software, in Iceland, and initially offered Turbo-Simplex for the IBM PC and Macintosh. By 1988, he started the development of the MPL Modeling System an algebraic modeling language that now is the main product of Maximal Software. In 1990, Mr. Kristjansson moved Maximal Software to the United States in order to be closer to what he considered the key markets for MPL.

At the same time major developments were occurring in the computer field, such as the growing popularity of Graphical User Interfaces (GUI's). In 1993, MPL was the first modeling system that was released for the Microsoft Windows platform. Shortly afterwards, both MPL for Macintosh and MPL for Motif (UNIX) were released. Using graphical user interfaces in a modeling system greatly enhances the productivity for both model developers and end-users.

The second enhancement that Mr. Kristjansson introduced to optimization modeling, through his research between 1991 and 1994, was the concept of directly linking the modeling language to relational databases. As a result, this new database connection allows model developers and consultants to create real world end-user applications by using commercial databases, such as MS Access and Paradox, to handle the user interface and hide the complexities of the model from the end-user.

Currently, Mr. Kristjansson's research is focused on Client-Server technologies and how they can be used in optimization modeling. Mr. Kristjansson believes that in the near future the user, from his desktop, will be able dispatch large optimization problems directly to a solver located on a server machine, that has extended computing capabilities, such as parallel, and all the connections will be handled automatically by the modeling system. To this end, Mr. Kristjansson is working with several other research partners to develop Client-Server technologies within the MPL Modeling System.

Another research area that interests Mr. Kristjansson is the recent developments of the Internet and the World-Wide-Web and how they may impact optimization modeling. Operating systems, such as MS Windows, and other end-user applications are already introducing the Web browser concept to handle their user interface. Mr. Kristjansson realizes that modeling systems, such as MPL, will need to integrate these new technologies in order to handle user interaction tasks such as data management and reporting.

Mr. Kristjansson, since 1988, has been a member of ORSA and TIMS, which were later merged into INFORMS. He is also member of CSTS, and the Harvey Greenberg's Intelligent Mathematical Programming Systems (IMPS) consortium. For several years, he has organized the software demonstrations at the CSTS track where software companies in the field of optimization and modeling have been able to demonstrate their software in popular and well attended sessions.

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New Books by CSTS Members

Tabu Search

Fred Glover and Manuel Laguna
University of Colorado, Boulder

This book explores the meta-heuristic approach called tabu search, which is dramatically changing our ability to solve a host of problems that extend over the realms of resource planning, telecommunications, VLSI design, financial analysis, scheduling, space planning, energy distribution, molecular engineering, logistics, pattern classification, flexible manufacturing, waste management, mineral exploration, biomedical analysis, environmental conversation and scores of other problems.

Tabu search has important links to evolutionary and "genetic" methods, often overlooked, through its intimate connection with scatter search and path relinking—evolutionary procedures that have recently attracted attention for their ability to facilitate the solution of complex problems. The adaptive memory designs of tabu search have also provided useful alternatives and supplements to the types of memory embodied in neural networks, allowing enhancements of neural network processes in practical settings. Hybrid procedures incorporating tabu search are similarly being used to provide enhancements of other types of processes for learning and problem solving.

The major ideas of tabu search are presented with examples that show their relevance to multiple applications. Numerous illustrations and diagrams are used to clarify principles that deserve emphasis, and that have not always been well understood or applied. The book's goal is to provide "hands-on" knowledge and insight alike, rather than to focus exclusively either on computational recipes or on abstract themes.

Tabu Search is designed to be useful and accessible to researchers and practitioners in management science, industrial engineering, economics, and computer science. It can be used as a textbook in a masters course or in a doctoral seminar. Because of its emphasis on presenting ideas through illustrations and diagrams, and on identifying associated practical applications, it can also be used as a supplementary text in upper division undergraduate courses.

The book's goal is to provide a grounding in the essential ideas of tabu search that will allow readers to create successful applications of their own. Along with the essential ideas, understanding of advanced issues are provided, enabling researchers to go beyond today's developments and create the methods of tomorrow.

Contents

Preface. 1. Tabu Search Background. 2. TS Foundations: Short Term Memory. 3. TS Foundations: Longer Term Memory. 5. Tabu Search Principles. 6. Tabu Search in Integer Programming. 7. Special Tabu Search Topics. 8. Tabu Search Applications. 9. Connections, Hybrid Approaches and Learning. 10. Neglected Tabu Search Strategies. References. Index.

Publisher Information

July 1997, Kluwer Academic Publishers, Boston, ISBN 0-7923-9965-X, 402 pp., cloth. USD $140.00 (price for student classroom adoption of six or more copies is USD $79.95). Fax: (617) 871-6528, Tel: (617) 871-6600, Email: *kluwer@wkap.com*

Neuro-Dynamic Programming

Dimitri P. Bertsekas and John N. Tsitsiklis
Massachusetts Institute of Technology

Neuro-Dynamic Programming (NDP for short), also known as reinforcement learning, is a recent class of methods that can be used to solve very large and complex dynamic optimization problems.

NDP combines simulation, learning, neural networks or other approximation architectures, and the central ideas in dynamic programming. It provides a rigorous framework for addressing challenging and often intractable problems from a broad variety of fields. This book provides the first systematic presentation of the science and the art behind this potentially far-reaching methodology.

The book is the winner of the 1997 INFORMS/CSTS Prize for research excellence in the interface between operations research and computer science.

Among its special features, the book:

- Describes and unifies a large number of NDP methods, including several that are new
- Includes a rigorous analysis of the mathematical principles behind NDP

- Describes new approaches to formulation and approximate solution of problems in stochastic optimal control, sequential decision making, and discrete optimization
- Illustrates through examples and case studies the practical application of NDP to complex problems from resource allocation, feedback control, data communications, game playing, and combinatorial optimization
- Presents extensive background and new research material on dynamic programming and neural network training

CONTENTS

1. Introduction. 2. Dynamic Programming. 3. Neural Network Architectures and Training. 4. Stochastic Iterative Algorithms. 5. Simulation Methods for a Lookup Table Representation. 6. Approximate DP with Cost-to-Go Function Approximation. 7. Extensions. 8. Case Studies. A: Mathematical Review. B: On Probability Theory and Markov Chains.

Publisher's Information

1996, 512 pp., hardback, ISBN:1-886529-10-8, $79.00, Athena Scientific, P.O.Box 391, Belmont, MA, 02178-9998, U.S.A. Email: *athenasc@world.std.com*, Tel: (617) 489-3097, FAX: (617) 489-2017. WWW Site for Info and Ordering: *http://world.std.com/~athenasc/*

Linear Programming: Foundations and Extensions

Robert J. Vanderbei
Princeton University

This book is an introductory graduate textbook on linear programming although upper-level graduate students and researchers will find plenty of material here that cannot be found in other books. It has also been used successfully to teach undergraduates majoring in Operations Research.

Contents

Preface. Part 1: Basic Theory - The Simplex Method and Duality. 1. Introduction. 2. The Simplex Method. 3. Degeneracy. 4. Efficiency of the Simplex Method. 5. Duality Theory. 6. The Simplex Method in Matrix Notation. 7. Sensitivity and Parametric Analyses. 8. Implementation Issues. 9. Problems in General Form. 10. Convex Analysis. 11. Game Theory. 12. Regression.

Part 2: Network-Type Problems. 13. Network Flow Problems. 14. Applications. 15. .Structural Optimization. Part 3: Interior-Point Methods. 16. The Central Path. 17. A Path-Following Method. 18. The KKT System. 19. Implementation Issues. 20. The Affine-Scaling Method. 21. The Homogeneous Self-Dual Method. Part 4: Extensions. 22. Integer Programming. 23. Quadratic Programming. 24. Convex Programming. Appendix A: Source Listings. Answers to Selected Exercises. Bibliography. Index.

Features

- Balanced treatment of the simplex method and interior-point methods.
- Efficient source code (in C) for all the algorithms presented in the text (available directly from the author's web site).
- Thorough discussion of several interior-point methods including primal-dual path-following, affine-scaling, and homogeneous self dual methods.
- Extensive coverage of applications including traditional topics such as network flows and game theory as well as less familiar ones such as structural optimization, L_1 regression, and the Markowitz portfolio optimization model.
- Over 200 class-tested exercises.
- A dynamically expanding collection of exercises available over the internet.

Publisher Information

Kluwer Academic Publishers, Boston, hardbound, ISBN 0-7923-9804-1, September 1996, 440 pp., NLG 240.00 USD 129.95 GBP 92.50. Special price of USD 79.95 for course adoptions with orders of six copies or more

Financial Networks: Statics and Dynamics

Anna Nagurney and Stavros Siokos
University of Massachusetts at Amherst,

The 500-page book presents a new theory of multi-sector, multi-instrument financial systems based on the visualization of such systems as networks. The framework is both qualitative and computational. Moreover, it

adds a graphical dimension to the fundamental economic structure of financial systems and their evolution through time.

Anna Nagurney is a Professor in the Department of Finance and Operations Management at the School of Management at the University of Massachusetts at Amherst. Stavros Siokos is with Salomon Brothers International in England in the European Quantitative Analysis Department.

Publisher Information

1997, Springer-Verlag, Heidelberg, Germany, ISBN 3-540-63116-X (hardback).

Interfaces in Computer Science and Operations Research

Richard S. Barr, Richard V. Helgason, Jeffery L. Kennington, eds.
Southern Methodist University

The disciplines of Computer Science and Operations Research have been linked since their origins and each have contributed to the dramatic advances of the other. This volume examines some of the recent advances resulting from the confluence between these two technical communities. In the process the book brings together the original work of academic researchers and practitioners in Computer Science, Operations Research, Management Science, Artificial Intelligence, Neural Networks, and related fields. More specifically, it explores the connections between these two areas with an array of advances in metaheuristics, neural networks, optimization, stochastic analysis, constraint logic programming, and decision support modeling.

The book's principal theme centers on the shared modeling technologies of Computer Science and Operations Research and applies these methodologies to a variety of applications in manufacturing, logistics, finance, and telecommunications.

Contents and Contributors

Part I: Metaheuristics. 1. Tabu Search and Adaptive Memory Programming - Advances, Applications and Challenges; F. Glover.

Part II: Neural Networks. 2. Neural Networks in Practice: Survey Results; B.L. Golden, et al. 3. Tractable Theories for the Synthesis of Neural Networks; V. Chandru, et al. 4. Neural Network Training via Quadratic Programming; T.B. Trafalis, N.P. Couellan. 5. A Neural Network Model for Predicting Atlantic Hurricane Activity; O. Kwon, et al.

Part III: Optimization. 6. An Efficient Dual Simplex Optimizer for Generalized Networks; J.L. Kennington, R.A. Mohammed. 7. Solving Large-Scale Crew Scheduling Problems; H.D. Chu, et al.

Part IV: Constraint and Logic Programming. 8. HOURIA III: A Solver for Hierarchical Systems of Functional Constraints, Planning the Solution Graph for a Weighted Sum Criterion; M. Bouzoubaa, et al. 9. Some Recent Developments of Using Logical Analysis for Inferring a Boolean Function with a Few Clauses; E. Triantaphyllou, et al.

Part V: Stochastic Performance Analysis. 10. Computational Analysis of a G/G/1 Queue with Vacations and Exhaustive Service; H. Li, Y. Zhu. 11. Stability and Queuing-Time Analysis of a Reader-Writer Queue with Writer Preference; L.C. Puryear, V.G. Kulkarni. 12. Importance Sampling in Lattice Pricing Models; S.S. Nielsen.

Part VI: Modeling and Decision Support. 13. Data and Optimization Modelling: A Tool for Elicitation and Browsing (DOME); H. Mousavi, et al. 14. Enhancing User Understanding via Model Analysis in a Decision Support System; D.M. Steiger.

Part VII: Applications in Manufacturing, Logistics, and Finance. 15. Bank Failure Prediction Using DEA to Measure Management Quality; R.S. Barr, T.F. Siems. 16. A Cooperative Multi-Agent Approach to Constrained Project Scheduling; D. Zhu, R. Padman. 17. Scheduling a Flow Shop to Minimize the Maximal Lateness under Arbitrary Precedence Constraints; J. Józefowska, A. Zimmiak. 18. A Genetic Programming Approach for Heuristic Selection in Constrained Project Scheduling; R. Padman, S.F. Roehrig. 19. Coupling a Greedy Route Construction Heuristic with A Genetic Algorithm for the Vehicle Routing Problem with Time Windows; J.-Y. Potvin, F. Guertin.

Publisher Information

1997, 450 pp., hardbound, ISBN 0-7923-9844-0, Kluwer Academic Publishers, Boston, NLG 220.00 / USD 119.95 / GBP 85.25 ●

Minutes of CSTS Business Meeting, San Diego

Matthew J. Saltzman, Secretary/Treasurer

May 5, 1997

Elections Harlan Crowder has been elected Vice-Chair/Chair-Elect. Bjarni Kristjansson is the new Secretary/Treasurer. Matthew Saltzman and Carol Tretkoff were elected to the Board of Directors, with terms expiring in 2000.

Financial Report Matthew Saltzman reported on the Section's financial status. In summary, as of March 31, 1997:

1996	Opening balance . . .	16,660.89
	Revenue	4,527.00
	Expenses	(5,248.46)
	Net from meeting . . .	1,515.23
1997	Opening balance . . .	17,454.66
	Revenue YTD	1,047.00
	Expenses YTD	193.07
	Balance	18,308.59

The INFORMS membership directory lists 649 CSTS members.

Journal on Computing Bruce Golden reports that the *Journal* is healthy, and the INFORMS board is happy with its progress toward profitability. The editorial board is strong—-a changeover of area editors went smoothly. Circulation is on pace with last year, although some institutional sponsors have not renewed. The backlog is in balance. *JoC* is abstracted in *IAOR*, *ISI*, and *Computer Abstracts*. A collection of JoC articles is to be published this year.

Recent issues included special features on networks and graphs (Fall, 1996), integer programming (Winter, 1997), and stochastic programming (Spring, 1997). Features in preparation include computational integer programming, the World Wide Web, and financial models.

Challenges for the future include increasing subscriptions, developing a World WIde Web site for the journal, attracting the latest and best papers (e.g., data mining), making sure that papers are processed carefully and quickly, and increasing institutional sponsorship.

Newsletter The newsletter is online at *http://orcs2.bus.okstate.edu/CSTS-web/* (accessible through the CSTS homepage at *http://www.math.clemson.edu/INFORMS/CSTS/*). Viewing the newsletter requires a PDF viewer such as Adobe Acrobat Reader (*http://www.adobe.com*), xpdf, or Ghostview.

The "member profile"' features have been well-received.

A new editor is needed for the newsletter. A lot of the infrastructure is already built for several platforms, so the next editor's job should not be too onerous.

CSTS Meeting, 1988 The plenary speaker for the upcoming Monterey conference will be John McCarthy, the father of LISP and one of the fathers of the field of Artificial Intelligence.

Conference information can be found at *http://www.gsm.ucdavis.edu/~woodruff/csts.html*. Session proposals are due by June 2. Kluwer has made LaTeX macros available via FTP. Contact Dave Woodruff at *dwoodruff@ucdavis.edu* for more information. Presentations for the book are due by June 16 and submitted presentations by September 15.

Conference on Information Systems Technology Program Chairperson Ramaya Krishnan (*rk2x@cmu.edu*) announced the Third CIST, to be held in conjunction with the Montreal meeting, April 26-28, 2998. The CIST will publish a refereed proceedings including all papers presented. More information is available at *http://www.heinz.cmu.edu/~rk2x/cist.html*.

CSTS Prize The CSTS Prize was awarded to Dmitri Bertsekas and John Tsitsiklis for their book, Neuro-Dynamic Programming (Athena, 1996). [*See p.14.-ed*]

Chairperson's report Dick Barr announced session-organizer forms for the Dallas meeting at *http://www.smu.edu/~barr/dallas97/*

Corrections Contact Matthew Saltzman (*mjs@clemson.edu*) with corrections.

Roster Many attendees escaped without signing the roster. The following people did sign: Bjarni Krijstiansson, Hemant Bhargava, Gordon Bradley, Joe Creegan, Ramesh Sharda, Ramayya Krishnan, Rema Padman, Mike Shaw, Barin Nag, Scott Rogers, Anna Nagurney, Matthew Saltzman. ●

Upcoming Meetings

CSTS'98: 6th INFORMS CSTS Conference on Computer Science & Operations Research

Monterey, California, USA, Jan 7-9, 1998

See article on page 6.

Algorithms and Experiments (ALEX98)

Trento, Italy, February 9 - 11, 1998

"Building bridges between theory and applications"

The aim of this workshop is to provide a discussion forum for researchers and practitioners interested in the design, analysis and experimental testing of exact and heuristic algorithms. In particular, the workshop will address methodological issues and significant case studies in the area of experimental analysis and tuning of algorithms, a subject whose importance is being recognized by a growing number of researchers in the CS community, both to assess the relevance or limitations of theoretical models and to create bridges toward applications in different domains. The scientific program will include the presentation of invited talks and contributed research papers.

Information

- URL *http://rtm.science.unitn.it/alex98*
- Email: *alex98@rtm.science.unitn.it*

Fourth INFORMS Telecommunications Conference

8-11 March 1998, Boca Raton, Florida

Sponsored by the INFORMS Section on Telecommunications

Final Call For Papers

In the tradition of the previous Conferences, all held at the Sheraton Boca Raton Hotel, the Fourth Conference will focus on the theory and application of Operations Research to problems in telecommunications, with particular emphasis on new and emerging networks.

Featured Speakers

The Keynote Speaker will be Dave Clark (MIT) and the Plenary Speakers will be Jerry Ash (AT&T), Dimitri Bertsekas (MIT), Tom Magnanti (MIT), and Ward Whitt (AT&T Labs).

Workshops

Two workshops are planned for Sunday, March 8: Mobile and Wireless Networking, given by Magda El Zarki (U Pennsylvania), and Multimedia Networking, given by Keith Ross (U Pennsylvania).

Topics For The Conference Include

IP networks and performance; World Wide Web (WWW) applications; ATM networks, pricing and QoS, wireless networks (architecture, design, congestion control protocols, network interconnection); gigabit networks; LANs, MANs and enterprise networks; Network Design; Video and Multimedia; Loss Networks; Network Management; Routing and Scheduling; Measurements and Traffic Characterization; Teletraffic Theory; Polling Models; Simulation; Reliability; Optimization; Mobility/Nomadicity; Access Control; Protocol Analysis; Queueing Models

ITC Mini-seminar

An INTERNATIONAL TELETRAFFIC CONGRESS (ITC) Mini-Seminar is planned to be "piggybacked" starting the day after the Conference (March 12, 1998), at the same hotel. Prosper Chemouil, CNET (*prosper.chemouil@issy.cnet.fr*), and Jim Schmitt, AT&T Labs (*jschmitt@att.com*), are the Conveners. Details on the ITC Mini-Seminar will be provided separately.

General Chairs

- Robert Doverspike, AT&T Labs (Research) - Room A105, 180 Park Avenue, Florham Park, NJ 07932-0971, USA
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- Robert B. Cooper, Dept. of Computer Science and Engineering, Florida Atlantic University, Boca Raton, FL 33431-0991, USA
  E-mail: *bob@cse.fau.edu*
  Phone: (561) 367-3673
  Fax: (561) 367-2800

Web Site

This announcement and other information of interest can be found on the Web site of the INFORMS Section on Telecommunications:

http://www.cstp.umkc.edu/informs-telecom/

INFORMS Israel 1998: Call for Papers

Tel-Aviv June 28-July 1, 1998

The theme of the meeting is Management Science and Operations Research in an Emerging Region. We hereby solicit papers for the session MODELING LANGUAGES AND APPROACHES which deals with the problematics of the procedure between the perception of a problem and its precise formulation for mathematical program or simulation or the like.

Prospective speakers should read the procedure of submission below.They can find further material at the meeting's web-site:

http://www.informs.org/Conf/TelAviv98/

Submission Procedure

Mail abstract to both:

- Contributed Papers, INFORMS Israel, 2 Charles Street, Suite 300, Providence, RI 02904, USA +1-800-343-0062 or +1-401-274-2525 or submit electronically to:
  http://www.informs.org/Conf/TelAviv98
- Copy to organizer of session, M. A. Pollatschek, Management, Technion, Haifa, 3200, Israel or send by e-mail to: *bani@ie.technion.ac.il*

Include U.S. $100 submission fee payable to INFORMS Israel. Applies towards registration fee.

19th IFIP TC7 Conference on System Modelling and Optimization

July 12-16, 1999, Cambridge, England

This meeting will address not only the usual topics of TC7 conferences, which include system modelling, optimal control, stochastic programming and a wide range of applications, but also special attention will be given to general algorithms for optimization calculations, because the main organiser is M.J.D. Powell. Please note the dates now. An International Programme Committee will choose the plenary speakers soon. Their names will be published in the first formal announcement of the conference, which will be available in January, 1998. That announcement will also invite the submission of papers for presentation in parallel sessions, but the deadline for submissions will be no earlier than 1/1/99. If you wish to receive further information about the conference, please send an e-mail message to: *tc7con@amtp.cam.ac.uk*. You should include your postal address if you would prefer to receive this information by ordinary mail.

M.J.D. Powell

MIC'99: III Metaheuristics International Conference

Rio de Janeiro, Brazil, 1999

The Third Metaheuristics International Conference will be held in a location on the southern coast of Rio de Janeiro, Brazil, in 1999. It is our intention to keep everyone in the "Metaheuristics family" informed during the planning process of MIC'99, and therefore a Web page will be created (November 1997) with this purpose at the following URL: *http://www.inf.puc-rio.br/~mic99*

We would like to have your input with respect to the dates for MIC'99, so we are asking you please to send e-mail to *mic99@inf.puc-rio.br* expressing your preferences for one of the following options: first half of June, second half of June, first half of July, second half of July, first half of August, and second half of August. Looking forward to hearing from you

Celso C. Ribeiro, Conference Chairman.●

Message from the Chair

Richard S. Barr

The Computer Science Technical Section is in excellent shape, with a healthy treasury, a sizable and active membership, a strong presence at the national INFORMS meetings, its own successful conference series, an excellent journal, an informative newsletter, an established and recognized prize for excellence, and attendees that know how to have a good time. Except for the latter, this is the result of over a decade of hard work by a large number of individuals.

On Becoming a Society

It is from this position of strength that CSTS is applying to change its status within INFORMS from that of a *section* to one of a *society*. Early indications are that our application is likely to be approved.

Initially, such a change will only mean a new name, but, in the long term, it should enhance the professional status of the group and permit us to undertake even more ambitious projects. As Harlan Crowder points out, people are more likely to include their membership in a society on their vita than membership in a section. Clearly, the IEEE Computer Society has benefited from its name and parental association, and provides a model of development that we could pursue. An update on this project will be given in the next newsletter.

Upcoming Meetings

The Dallas meeting had 20 CSTS research and software demonstration sessions, and the spring Montreal meeting will have a similar number. The upcoming CSTS'98 in Monterey has an excellent program and it is hoped that the East Coast will not be snowed in (for the third meeting in a row).

Other Projects

- INFORMS has requested that the sections and societies develop liaisons with other professional societies with similar interests. Asim Roy has volunteered for that role with the IEEE Neural Network Society. We are seeking liaisons with other groups, such as ACM, IEEE Computer, SIAM, and MPS; if you have an interest, please contact me.
- To my surprise, we have little in the way of a formal institutional memory. Much of the information on how CSTS operates is passed along by word of mouth, from helpful predecessors to successors. I am documenting the various processes and procedures so that the surprises are fewer for future officers and volunteers.
- Each spring we elect a new vice-president/president-elect and two new directors for the CSTS board. If you are interested in any of these positions, please let myself or Harlan Crowder know.

Newsletter Changes

Because a new editor was not forthcoming by last summer, and because "the buck stops here," I ended up with the special assignment of producing this *Newsletter* edition. The new style is designed to give it a "browser" look, which seemed appropriate, especially for our electronic version. Thanks to all of the contributors that helped bring this issue together.

I am glad that we will have a new editor for the next *Newsletter*. Managing this edition has helped me truly appreciate the enormous amount of work that Hemant Bhargava, Deepali Bhargava, the associate editors, and their predecessors devoted to this publication. ●